

wind storm passed over Madison and this place on the 19th. The hail-stones were as large as hen's eggs, and were destructive to corn and other crops.

Sharpsburg, Alleghany county, Pennsylvania: on the 22d, at 7.30 p. m., an unusually heavy hail storm occurred at De Haven Station, on the Pittsburg and Western Railroad.

Grafton, Walsh county, Dakota: on the afternoon of the 24th a disastrous thunder and hail storm passed over this vicinity. The storm travelled eastward, and from Saint Thomas across the Red River into Minnesota, it passed over an area five miles in width and thirty in length. Within this space hail-stones fell as large as hen's eggs and were unusually destructive. The wheat crop on 250,000 acres is reported to have been entirely destroyed, leaving many farmers destitute. Several persons were severely injured.

Saint Vincent, Minnesota: a very heavy thunder-storm, accompanied by rain and hail, occurred here on the afternoon of the 24th; serious injury was sustained by all kinds of vegetation.

Warren, Marshall county, Minnesota: this county was visited by a destructive hail-storm on the night of the 24-25th. The storm commenced at the town of Argyle, and passed over the towns of Middle River, Alma, Toldol, and Comstock. Hail as large as hen's eggs fell for about twenty minutes, destroying grain and breaking windows. It is reported that 25,000 acres of grain were destroyed in the vicinity of Mayville.

Sharon, Mercer county, Pennsylvania: on the afternoon of the 29th a destructive hail storm occurred in this county. Corn and other crops were in many places completely ruined.

Williamsport, Lycoming county, Pennsylvania: on the afternoon of the 29th a hail storm of great severity visited the western part of this county. Hail fell in great quantities, and many of the stones were as large as hen's eggs.

Hail was also reported to have fallen in the various states and territories on the following dates:

Arkansas.—Little Rock, 10th.

Colorado.—Pike's Peak, 2d, 17th, 19th; Montrose, 12th.

Connecticut.—New Haven, 18th; Southington, 29th.

Dakota.—Webster, 2d; Bismarck, Fort Totten, and Fort Yates, 3d; Fort Meade, 6th.

Illinois.—Pekin, 9th; Windsor, 9th, 14th; Chicago, 13th.

Indiana.—Logansport, 12th; Lafayette, 12th, 13th.

Iowa.—Keokuk, 9th; West Union, 12th.

Kansas.—Salina, 7th; Allison, 18th.

Kentucky.—Louisville and Frankfort, 14th.

Maine.—Portland, 19th.

Massachusetts.—Heath, 26th, 27th; Edgartown and Princeton, 30th.

Michigan.—Detroit and Grand Haven, 13th.

Missouri.—Central College, 13th.

Montana.—Fort Assinaboine and Helena, 4th.

Nebraska.—Valentine, 27th; Hay Springs, 30th.

Nevada.—Carson City, 16th, 19th.

New Jersey.—Readington, 18th; Sandy Hook, 30th.

New York.—Penn Yan, 17th; White Plains and Factoryville, 18th; Ithaca and Menand's Station, 29th.

Ohio.—North Lewisburg, 7th; Cincinnati, Yellow Springs, and Tiffin, 14th; Cleveland, 13th, 14th, 29th; Columbus and Garrettsville, 17th; Hiram, 17th, 26th.

Oregon.—Roseburg, 19th.

Pennsylvania.—Pittsburg, 17th; Wellsborough and Eastbrook, 17th, 26th.

South Carolina.—Stateburg, 12th, 14th; Spartanburg, 14th.

Tennessee.—Nashville, 10th; Knoxville, 10th, 14th; Austin, 13th.

Utah.—Frisco, 19th.

Vermont.—Strafford, 18th.

Virginia.—University of Virginia, 8th, 23d; Dale Enterprise, 14th, 25th; Wytheville, 8th, 14th; Chincoteague, 23d; Variety Mills, 27th.

West Virginia.—Clarksburg, 13th.

Wisconsin.—Madison, 10th, 11th, 19th.

SLEET.

Sleet occurred at Pike's Peak, Colorado, on the following dates: 4th to 7th, 12th, 16th, 20th, 21st, 22d, 25th, 27th, 31st; at Mount Washington, New Hampshire, on the 23d.

RAIN FROM A CLOUDLESS SKY.

The observer at Louisville, Kentucky, states that "on the 27th, at 12.30 a. m., the unusual phenomenon of rain from a cloudless sky was observed; light rain fell for ten minutes."

TEMPERATURE OF WATER.

The following table shows the highest and lowest temperatures of water observed at the several stations; the monthly ranges of water temperature; the average depth at which the observations were made; and the mean temperature of the air:

Temperature of water for July, 1886.

Station.	Temperature at bottom.		Range.	Average depth, feet and tenths.	Mean temperature of the air at station.
	Max.	Min.			
Atlantic City, New Jersey	77.0	69.4	7.6	12.1	72.2
Alpena, Michigan	72.6	63.5	9.1	12.5	64.4
Augusta, Georgia	86.0	70.4	15.6	12.9	77.9
Baltimore, Maryland	78.9	72.0	6.9	11.9	74.4
Block Island, Rhode Island	66.9	61.4	5.5	9.0	68.7
Boston, Massachusetts	68.7	63.1	5.6	21.3	70.8
Buffalo, New York	76.0	69.0	7.0	10.3	68.5
Cedar Keys, Florida	85.0	80.3	5.3	8.0	80.3
Charleston, South Carolina	85.1	80.4	4.7	38.2	79.9
Chicago, Illinois	72.7	67.0	5.7	9.1	71.4
Chincoteague, Virginia	84.1	72.0	12.1	3.5	74.5
Cleveland, Ohio	75.0	67.9	7.1	14.0	69.9
Detroit, Michigan	72.9	67.8	5.1	26.6	71.0
Duluth, Minnesota	69.4	59.3	13.1	9.6	66.1
Eastport, Maine	51.3	46.6	4.7	16.7	60.8
Escanaba, Michigan	66.7	57.3	9.4	18.2	65.5
Galveston, Texas	88.8	84.1	4.7	13.2	82.8
Grand Haven, Michigan	74.5	61.0	13.5	19.0	65.9
Indianola, Texas					
Jacksonville, Florida	85.7	81.0	4.7	18.0	80.9
Key West, Florida	89.5	82.7	6.8	18.6	85.7
Mackinaw City, Michigan	67.5	61.3	6.2	10.0	64.5
Macon, Fort, North Carolina	85.9	74.4	11.5	11.9	78.9
Marquette, Michigan	64.3	46.2	18.1	12.0	64.1
Milwaukee, Wisconsin					
Mobile, Alabama	84.5	79.1	5.4	17.7	78.6
New Haven, Connecticut	76.5	67.0	9.5	16.6	70.1
New London, Connecticut	70.3	62.0	8.3	13.4	70.2
New York City	75.8	68.3	7.5	16.2	72.9
Norfolk, Virginia	81.2	73.3	7.9	16.5	76.1
Pensacola, Florida	80.5	81.3	5.2	17.5	80.2
Portland, Maine	60.9	54.6	6.3	16.9	66.5
Portland, Oregon	75.4	66.4	9.0	54.0	67.4
Sandusky, Ohio	78.6	71.5	7.1	11.4	71.0
Sandy Hook, New Jersey	75.0	66.9	8.1	13.6	72.7
San Francisco, California	62.2	55.8	6.4	37.1	59.1
Savannah, Georgia	81.7	76.2	5.5	10.5	80.5
Smithville, North Carolina	84.8	76.2	8.6	10.8	79.5
Toledo, Ohio	77.0	72.1	5.9	13.5	71.4
Wilmington, North Carolina	82.9	76.1	6.8	10.3	78.6

• Observations temporarily suspended.

WINDS.

The most frequent directions of the wind during July, 1886, are shown on chart ii by the arrows flying with the wind; they are also given in the table of miscellaneous meteorological data. In the Gulf States and Florida the prevailing direction of the wind is from the south; in the south Atlantic states from the southwest. In all other districts it is variable.

HIGH WINDS.

[In miles per hour.]

Wind-velocities of fifty or more miles per hour were recorded during the month, as follows:

Mount Washington, New Hampshire, 70, w., 6th; 82, w., 7th; 64, nw., 8th; 59, nw., 10th; 66, w., 11th; 70, w., 12th; 55, se., 14th; 65, se., 15th; 84, sw., 16th; 59, w., 19th; 59, w., 20th; 59, nw., 22d; 58, nw., 23d; 65, nw., 24th; 50, nw., 27th; 50, w., 29th; 62, w., 30th.

Pike's Peak, Colorado, 61, w., 1st.

Nashville, Tennessee, 75, nw., 10th.

Key West, Florida, 52, sw., 18th.

Fort Elliott, Texas, 64, nw., 19th.

Fort Assinaboine, Montana, 59, w., 26th.

Sandy Hook, New Jersey, 72, nw., 30th.

LOCAL STORMS AND TORNADOES.

Chart number vii gives isobars, isotherms, and wind-directions for 10 p. m., July 13, 1886. This chart is given in order to show the above elements a few hours before the occurrence of a tornado at Barnesville, Ohio, and destructive storms at Newark, Shelby, Steubenville, New Alexandria, Mingo Junction, Smithfield, and Wooster, Ohio; Mercer, Millbrook, Corry, and Carlton, Pennsylvania; Chautauqua Lake and Randolph, New York, besides heavy thunder and hail storms through Ohio, western Pennsylvania, and New York. The severest part of this storm action passed Cincinnati, Ohio, at 1.10 a. m.; Columbus, Ohio, at 2.20 a. m.; and Pittsburg, Pennsylvania, at 4.15 a. m. The low area accompanying had a velocity of about thirty-two miles per hour. These storms were some twelve hours earlier than the destructive storms in Virginia, for which chart viii has been prepared.

Fort Yates, Dakota: between 6.40 and 8.30 p. m. of the 3d a heavy thunder-storm, accompanied by destructive hail and high wind, passed over this place. The hail-stones were very irregular in shape and varied in size from a pea to a walnut; they fell to a uniform depth of one inch, and with great force, making indentations in boards, fences, and buildings, and breaking over a thousand panes of glass. Vegetables in the post and Indian agency gardens were completely destroyed, as well as considerable wheat in the surrounding country. During the storm the wind attained a maximum velocity of fifty miles per hour, blowing down trees, fences, and chimneys. The rainfall, 3.33 inches, was heavier than any since the establishment of the Signal Service station at this point, causing the Missouri River to rise three feet during the passage of the storm. The total damage is estimated at \$25,000.

Los Angeles, California: on the 4th a light shower of rain began at 1.20 p. m., becoming quite heavy at 1.30 p. m., and continued falling until 2.40 p. m., when it ceased. The amount of precipitation was 0.24 inch. Distant thunder was heard between 1.50 and 1.55 p. m., but no lightning was seen. The temperature, which was high in the morning, fell during the storm and rose rapidly after, attaining a maximum of 97°.7. The rain seems to have been local, light sprinkles being reported from neighboring places, and other localities in this section reporting no rain. This rain was the first, except light sprinkles scarcely traceable, that has fallen in July at this place since the Signal Service station was established here, and old residents state that they have never known a rain storm in July, though rain has fallen in August. On the 17th a thunder and rain storm occurred in the desert several miles southeast of Los Angeles.

Savannah, Georgia: the observer at this place reports, concerning a phenomenon which occurred on the 4th, as follows:

At 2.05 p. m. a very heavy, low, black cloud, from which there was apparently heavy precipitation, passed north of the station. A funnel-shaped cloud extended from the lower edge of the large cloud referred to to apparently midway between the earth and the base of the large cloud. As the cloud moved eastward the inverted cone swung backward and forward, but did not descend to the earth. The phenomenon lasted about four minutes.

Scranton, Pennsylvania: a very severe thunder-storm, accompanied by hail and high wind, occurred here on the afternoon of the 7th. The storm began at 6 p. m., and during the succeeding fifteen minutes the wind blew with almost tornado force. Trees in various parts of the city were uprooted, houses unroofed, fences blown down, and windows broken. Considerable damage was also incurred by farmers in the surrounding country.

Chicago, Illinois: on the night of the 9-10th an extensive thunder-storm occurred in the central and northern parts of this state. Considerable damage was done by lightning, and much grain destroyed by heavy rain and wind. Lightning struck the Ohio and Mississippi Railroad station at Bridgeport and burned a quantity of freight and express matter. The stations at Sumner and Lawrenceville were also partly destroyed by lightning, which set fire to the switch-boards. Around

Champaign considerable damage was done to crops, one house was burned by lightning and several were unroofed by the high wind. At Clinton the National Bank block was badly damaged, and trees and telegraph poles blown down. Owing to the intensity of the atmospheric electricity, telegraph wires were temporarily rendered useless. At Bloomington the storm assumed the characteristics of a tornado; a funnel-shaped black cloud appeared in the northwest about 7 p. m. and shortly after passed over the city, but beyond blowing down trees and signs little damage was done.

Nashville, Tennessee: a very severe gale and thunder-storm visited this city on the 10th. Between noon and 12.10 p. m. the wind blew at the rate of seventy-five miles an hour. Hundreds of trees were blown down and many houses were unroofed. Lightning struck and ignited three stables, which were destroyed.

Savannah, Georgia: a tornado occurred in Oothecala Valley, Gordon county, on the 10th. The storm did considerable damage to crops and trees.

Baltimore, Maryland: at 7.15 p. m. of the 15th a well-defined tornado, having a width of about fifty yards, but of slight destructive power, passed over the western part of this city, blowing down trees and unroofing about fifty houses, entailing a loss of \$15,000. The track of the tornado was about two miles in length with a general direction of north ten degrees east. Eye witnesses of the phenomenon describe it as a black, balloon-shaped cloud, the lower portion having the appearance of dense smoke whirling rapidly in a direction contrary to the hands of a watch and alternately rising and falling.

San Francisco, California: during the morning of the 16th quite a severe thunder-storm occurred here and along the coast from Soledad to Vallejo. The thunder and lightning were unusually heavy for this place and the rainfall, 0.23 inch, was almost unprecedented, being more than any previous record for July since 1849.

Petersburg, Virginia: on the 18th a very destructive wind storm passed over the upper portion of Lunenburg county. In some parts of its course the wind attained the velocity of a tornado, large trees were uprooted, many out-houses blown down or unroofed, and fences leveled to the ground. The storm was quite injurious to crops; corn and tobacco being blown down, and much fruit destroyed.

Garden City, Sequoyah county, Kansas: a severe wind and rain storm occurred at Lakin, twenty-two miles west of here, at 5 p. m. of the 19th. Twenty houses were demolished and ten persons injured. The heavy rain which accompanied the storm did much good to crops which had been suffering from drought.

Omaha, Nebraska: a heavy storm of wind, rain, and hail occurred in western Nebraska and eastern Wyoming on the afternoon of the 19th. Near Pine Bluffs, Wyoming, thirty telegraph poles were blown down, several houses unroofed, and the Union Pacific Railroad track was badly washed. In Minden, Kearney county, Nebraska, the storm was quite severe, one house was struck by lightning, three persons lost their lives, and several were injured.

Topeka, Kansas: during the night of the 18th and morning of the 19th heavy rain and high winds prevailed over this part of the state. At Nickerson eighteen houses were blown down and a number of other buildings unroofed. The rain was of much benefit to farmers whose crops had been suffering from drought.

Dodge Centre, Dodge county, Minnesota, was visited by a severe thunder-storm and high wind on the afternoon of the 19th. The damage to crops in Dodge and Olmstead counties was considerable. In Chippewa county seven hundred acres of wheat were almost completely destroyed by hail.

Tuscola, Douglas county, Illinois: about noon of the 20th a destructive wind and hail storm occurred in the vicinity of this place, leveling crops and orchards to the ground and otherwise injuring property.

Report of tornadoes for the month of July, 1886, by Lieut. J. P. Finley, Signal Corps, U. S. Army, Assistant.

Place.	Date.	Time.	Direction.	Form of cloud.	Number of persons killed.	Number of persons wounded.	Width of path.	Number and kind of animals killed.	Number and kind of buildings destroyed.	Total valuation of property destroyed.	Authority.
							Yards.				
Florence, South Carolina	1	Not given.		Funnel					1 dwelling	Light	"Atlanta Constitution" and clippings.
Dallas, Missouri *	8	5.30 p. m.	se.	Funnel						Light	E. H. Matney.
Middleton, Kentucky †	8	6 p. m.		Funnel						Light	John W. Jones.
Sleepy Eye, Minnesota ‡	9	12.30 a. m.		Funnel			25	Several horses	1 round-house, barns, chimneys, and out-buildings.	Great	"Pioneer Press," Saint Paul, Minnesota.
Bloomington, Illinois	9	7.30 p. m.	s.	Funnel						Great	"Evening Star," Washington, D. C.
De Leon and Mooresville, Texas	12	1 to 5 p. m.							1 church, 1 school-house, and several dwellings.	Great	"Chicago News," and clippings.
Millbrook, Pennsylvania	13	Night	e.	Funnel			15		1 barn	Light	Clippings.
Newark, Ohio	14	2.30 a. m.	n.	Funnel					2 buildings	Great	Clipping.
Barnesville, Ohio	14	2.30 a. m.	ne.	Funnel			50		Several barns, stables, and dwellings.	Great	D. H. Kemp, "Barnesville Republican," and clippings.
Lunenburg County, Virginia	18	Not given.		Funnel in air.			30		Many out-houses.	Considerable	"Saint Louis Globe-Democrat."
Petersburg, Dakota	23	4.30 p. m.	e.	Funnel			20		Few buildings		J. H. Peterson.
Great Barrington and Leominster, Massachusetts. ‡	30	Not given.		Funnel			25		Several dwellings	Considerable	"Berkshire Courier" and "Cincinnati Enquirer."
Potaskola, Allen town, and Vaughnsville, Ohio	30	10.40 a. m.	e.	Funnel	Many	Many	50	Many animals	Many	Considerable	"The Washington Post."
Wethersfield, Connecticut	30	5 a. m.	se.	Funnel							"Hartford Times" and "Saint Louis Globe-Democrat."
Wethersfield, Vermont	30	Not given.	se.	Funnel			25		Many	\$20,000	"Cincinnati Enquirer."

* Tornado in air, with very high wind at surface.

† Apex touched ground, and electric bolt discharged, burning portion of corn field and plowing path three feet deep in its course.

‡ Two heavy, dark clouds, one in the nw. and the other in ne., driven by a furious wind, rapidly approached the city and met near the round-house, and did considerable damage.

§ Mr. Brainard, while watching the clouds as they approached, saw one which had a very peculiar motion. While it kept on horizontally it would drop down to a point and then be drawn up, all the time whirling rapidly.

Philadelphia, Pennsylvania: on the night of the 22-23d a storm of wind and rain passed over this city and did considerable damage, especially in that part south of Reed street. Several houses were unroofed and a number of trees blown down.

Huron, Dakota: on the afternoon of the 24th a heavy thunder and hail storm occurred about four miles south of this place. Some of the hail-stones were as large as a walnut. Hail fell over an area of country two miles wide and two and a half long; within this space crops were seriously injured by hail and wind.

Fort Assinaboine, Montana: on the 26th fair weather, with brisk winds from the southwest and west, prevailed, except for a short time during the afternoon, when a high westerly gale of fifty-nine miles per hour set in. For a few minutes the wind attained a velocity of nearly seventy miles per hour, filling the air with sand, and even small gravel, and shaking heavy brick buildings. A large brick storehouse forty-five by one hundred and fifty-five feet, belonging to the Quartermaster's Department, was leveled to the ground. This storm possessed none of the features of a tornado, but was merely a violent gale.

Columbus, Ohio: the morning of the 30th was cloudy and threatening with wind from the south until 1.55 p. m. when it suddenly veered to the northwest. At 2 p. m. heavy rain began falling, with a gale of thirty-nine miles per hour from the northwest; the high wind continued until 2.40 p. m., when it began to subside, rain ceased falling at 3.20 p. m.; total fall in an hour and twenty minutes, 2.83 inches. The storm did considerable damage in the city and surrounding country. In the city the greatest injury to property was done in the northern and central portions. The Columbus rolling mill was demolished, killing one person and injuring twelve; the loss incurred was about \$5,000. The Union depot was damaged to the extent of about \$1,000, a part of the roof being blown off. Numerous dwellings were unroofed, and cellars in all parts of the city were flooded.

Windsor, Illinois: on the 30th a severe storm passed south of this place, doing considerable damage to trees and fences, and blowing down wheat and hay-stacks.

COTTON REGION REPORTS.

In the following table are given the means of the maximum and minimum temperatures and the average rainfall for the cotton districts during the month of June. For the purpose of comparison, the averages for these districts during the four preceding years are also given. The rainfall, as compared with the average of four years, is excessive in the districts of Wilmington, Savannah, Augusta, Atlanta, and Montgomery; in the remaining districts the rainfall was below the average, the deficiencies in the Vicksburg and Memphis districts being large. The mean of the maximum temperatures was below the average in all districts, except that of Memphis.

Temperature and rainfall data for the cotton districts, July.

Districts.	Rainfall.			Temperature.								Extremes for July, 1886.	
	Average for July of four preceding years.	Average for July, 1886.	Departures.	Maximum.				Minimum.					
				Mean for July of four pre- ceding years.	Mean for July, 1886.	Departures.	Mean for July of four pre- ceding years.	Mean for July, 1886.	Departures.				
Inch.	Inch.	Inch.	°	°	°	°	°	°	°	°	°	Max.	Min.
New Orleans...	4.26	4.26	+ 0.00	93.3	91.5	- 1.8	73.6	71.2	- 2.4	100	61		
Savannah...	5.12	8.21	+ 3.09	92.8	90.4	- 2.4	71.8	72.6	+ 0.8	101	64		
Charleston...	6.42	6.14	- 0.28	92.0	90.3	- 1.7	70.6	70.1	- 0.5	99	61		
Atlanta...	3.77	4.99	+ 1.22	90.6	88.7	- 1.9	68.8	68.3	- 0.5	100	57		
Wilmington...	4.61	8.43	+ 3.82	91.0	89.3	- 1.7	68.8	69.2	+ 0.4	105	59		
Memphis...	4.30	2.21	- 2.09	90.3	90.5	+ 0.2	68.8	67.1	- 1.7	104	45		
Galveston...	2.18	1.72	- 0.46	95.5	94.7	- 0.8	72.5	73.5	+ 1.0	108	33		
Vicksburg...	5.63	3.00	- 2.63	92.2	91.4	- 0.8	71.1	72.4	+ 1.3	98	33		
Montgomery...	4.22	4.70	+ 0.48	92.1	90.1	- 2.0	69.0	69.1	+ 0.1	102	35		
Augusta...	3.56	5.53	+ 1.97	92.7	90.0	- 2.7	70.4	68.9	- 1.5	100	37		
Little Rock...	2.55	2.75	+ 0.20	93.0	91.9	- 1.1	67.9	68.9	+ 1.0	103	30		
Mobile...	3.87	3.42	- 0.45	93.9	91.7	- 2.2	70.7	69.2	- 1.5	105	32		

NAVIGATION.

STAGE OF WATER IN RIVERS.

Owing to the great deficiency of rainfall in the Missouri Valley during May, June, and July, the river has been falling slowly. On the 18th the steamer "Rosebud," drawing less water than any boat running on the upper Missouri, arrived at the mouth of the Marias River, twelve miles below Fort Benton, Montana, and on account of the low water was unable to pro-